

REMARKS

Favorable reconsideration of this application and the Office Action of November 29, 2004 are respectfully requested in view of the following remarks.

Claims 1 to 36 remain under consideration in this application.

The indication of the allowability of claims 13 and 30 and that they would be allowed if written in independent form including the limitation of the base claims and any intervening claims is noted with appreciation. However, it is not considered necessary to rewrite these claims in independent form since the independent claims from which they are dependent are considered to be allowable for the reasons set forth hereafter.

The present invention relates to **non-photosensitive** polyimide precursor compositions that are **soluble in gamma-butyrolactone and aqueous tetramethyl ammonium hydroxide** and which **have certain specified adhesion promoters (of formulae I through VI)** that enable the **compositions not to be degraded as to stability of the composition**.

For the present invention, the polymer and the polymer composition have the following characteristics:

1. The polyimide precursor polymer must be soluble in gamma butyrolactone with/without co solvent (such compositions are not obvious; see comparative examples 1-6) .
2. The polymer must be alkali soluble to sufficient degree (large dissolution rate ranges; such polymers are not obvious that all will be alkali soluble; see Table 1 and Comparative Example 1).

3. The polymer must be photoresist solvent resistant (again this feature is not obvious. See Table 1).

4. The adhesion promoter must be stable in the solution (likewise this feature is not obvious; see Table 3).

The present Inventors have discovered that only certain adhesion promoters enable one to obtain such essentially non-degradable, stable non-photosensitive polyimide precursor compositions that are soluble in *gamma*-butyrolactone and aqueous tetramethyl ammonium hydroxide and possess improved adhesion without degradation and instability, possessing the four above listed characteristics, whereas other adhesion promoters are not able to provide such stable compositions and in fact lead to degradation (gelling) of such non-photosensitive polyimide precursor compositions that are soluble in *gamma*-butyrolactone and aqueous tetramethyl ammonium hydroxide. This unexpected discovery is illustrated in Applicants' specification, particularly in the inventive and the comparative examples in paragraphs [0069] and [0070] and particularly in the data in Tables 1 and 3 at pages 36, 39 and 40. This data clearly demonstrates the unobviousness of the present invention, and thereby the erroneousness of the USPTO's prior art obviousness rejection of the claims over the cited prior art for the reasons set forth hereinafter.

The rejection of claims 1-12, 14, 17-29, 31 and 34-34 under 35 U.S.C. 103 as being unpatentable over Yamashiki et al (US 6,455,208 B1) in view of Matsuoka et al. (US 5,397,682) is again respectfully traversed. It is respectfully submitted that a proper reading and understanding of these reference disclosures demonstrates that their disclosures do not teach or render obvious the claimed invention.

It is agreed that Yamashiki et al. discloses polyamic acids within the scope of the claims. As previously stated in Applicant's prior Response, Applicants' do not contend that their polyamic acids are new, rather that the stable compositions thereof in *gamma*-butyrolactone, with the specific adhesion promoters of formulae I through VI, are new and unobvious. Yamashiki et al. does not disclose compositions having the adhesion promoters

required by the present invention and claims of this application. This fact the PTO correctly recognizes. That is logical because, based on the state of the art, those skilled in the relevant art were unaware of adhesion promoters that would provide stable compositions. Although the reference does not disclose the use of adhesion promoters, the PTO, on its own, tries to cure this deficiency of the Yamashiki et al. patent disclosure by suggests that use of the adhesion promoters of Applicants' claims in Yamashiki et al's composition would be obvious and suggest using one from the disclosure in Matsuoka et al. This PTO position is clearly hindsight based solely upon Applicants' invention. Nothing in Yamashiki et al. suggest that any adhesion promoter could or should be used, nor any adhesion promoter that could be used provide a stable composition, nor is there anything to lead that person to select a specific adhesion promoter from Matsuoka et al. Thus, this hindsight reconstruction of the art is erroneous and requires the rejection to be withdrawn.

Furthermore, the PTO erroneously attempts to cure this deficiency in Yamashiki et al. by relying upon erroneous supposed equivalencies (characterized by the PTO as "permissible hindsight" in paragraph #10 of the Action). The present Inventors' invention and the invention in Yamashiki et al. both are directed to **non photosensitive** polyamic **acid** compositions. In contrast, Matsuoka et al. is directed to **photosensitive** polyamic acid **diester** compositions. Although in both instances the polymers of these compositions are polyimide precursors, these are:

- a) **two quite different type materials in different type formulations, and**
- b) **are employed in different environments in different ways for different purposes.**

The PTO, with no supporting evidence, has erroneously assumed that the adhesion requirements and solution stability for the photosensitive polyamic acid diester are equivalent to that for a non-photosensitive polyamic acid. Such a bold assumption is erroneous since obtaining good adhesion is a combination of chemistry and physical factors that depend on a number of factors, including the substrate, the cleanliness and preparation of the substrate, surface energies, the specific polymers used, other materials in the formulation, and the specific adhesion promoter being employed. Different adhesion mechanisms are involved in different environments with different materials. The adhesion

obtained can be from either physical means (e.g., entanglement of substituents) or chemical means (i.e. covalent or ionic bonding), or combinations of both. These factors combine to make it unapparent and unobvious which adhesion promoter materials will give sufficient adhesion in a given composition and situation or environment. Obtaining good adhesion is frequently done by trial and error. It is clearly established in many decided cases that mere trial and error or "obvious to try" standard is an erroneous standard for the PTO to attempt to establish obviousness under 35 U.S.C. 103. Thus, for these reasons, this rejection of the claims under Section 103 over Yamashiki et al. in view of Matsuoka et al. is clearly erroneous and its withdrawal is respectfully requested.

The PTO's unsupported conclusion of supposed equivalency between Matsuoka et al. and Yamashiki et al. is also erroneous for various additional reasons as detailed hereafter.

The polarity of polyamic acids and polyamic acid diesters are quite different, as are their reactivities. The polyamic acids have polar, reactive, carboxylic acid groups. The polyamic acid diesters are relative nonpolar, and typically will only react through double bonds in the ester groups, which requires an initiator. It can be readily seen because of the polarity and reactivity differences, that the adhesion situation will be different. Which adhesion promoters will be effective are thus, not obvious. **While Matsuoka describes using an internal adhesion promoter, it is with the polyimide precursor having diester groups, whose reactivity to other functional groups (e.g., in the adhesion promoter) is far lower than that of polyamic acid groups in the claims of the present invention.** It is, therefore, further not obvious which adhesion promoters will be stable enough to use as an internal adhesion promoter in gamma butyrolactone, since reaction rates can change significantly with solvent changes and with the reactivity of the functional groups on the polymer (acid vs ester). The rejection is also erroneous for this additional reason.

Moreover, the adhesion promoter has to work through a variety of different processing conditions. In the case of a polyamic acid composition as a underlying layer on

a substrate in a bilayer imaging process, the polyamic acid must maintain adhesion through various baking steps, the developing step(s), photoresist coating step and during and after the curing steps. As noted previously, **the polyamic acid composition is not photosensitive**. Thus, to pattern it, a photoresist must be coated on top. The polyamic acid film, in addition to having solvent resistance to the solvent employed in the photoresist, must maintain adhesion through the photoresist coating and baking process. This has no exact parallel in the processing of photosensitive polyamic acid diesters. In addition, the development step for the polyamic acid is with AQUEOUS tetramethyl ammonium hydroxide. This has no exact parallel with the processing of the polyamic acid diesters and places different requirements on the composition to maintain adhesion.

Polyamic acid diesters are coated, baked, exposed, optionally baked, developed with organic solvents and then cured. **The polyamic acid esters described in Matsuoka et al. do not meet the aforementioned criteria #2 of alkali solubility set forth at the bottom of page 2 of this Response.** Therefore, the diester compositions of Matsuoka et al. require an organic solvent developer to develop the patterned image because of the differences in functional groups. (see column 12, lines 22-32 of Matsuoka et al.) Representative solvents include NMP, dimethylacetamide, and gamma butyrolactone, whereas, in contrast, such solvents are quite likely to dissolve the polyamic acid coating.

After reviewing the processes, one can easily understand that the requirements to preserve adhesion when processing a polyamic acid are not the same as those processing a polyamic acid diester, particularly during the development step where the alkaline aqueous tetramethylammonium hydroxide is employed as the developer. The polarities and chemistry of the developing solvents (aqueous tetramethyl ammonium hydroxide vs., e.g., gamma butyrolactone) are completely different as are the nature of the polar acid groups and the relatively nonpolar polyamic acid diester.

Thus use of Matsuoka et al's disclosure to cure the deficiency of Yamashiki et al. is erroneous and withdrawal of the Section 103 rejection of claims 1-12,14,17-29, 31 and 34-36 over Yamashiki et al in view of Matsuoka et al. is respectfully requested.

It is further to be noted and considered by the PTO that the compositions of Yamashiki et al. do not require complete solubility in the organic solvent (present invention criteria #1- see page 2 of this Response), although it is preferred (column 14 line 66- column 15 line 2). The final composition in Yamashiki et al. has numerous other additives, some of which are not soluble, so that **the composition is applied as a paste**. In contrast, it is critical that the compositions of the present invention be completely soluble in the solvent so that it can be filtered and particle free coatings can be obtained. **Comparative Examples 3-6 of the present application all fall generally into the description of Yamashiki et al. (all of the monomers employed for those examples are also specifically mentioned).** All of these comparative examples failed the solubility test for GBL and thus are not useful for the present invention. Thus it is not apparent or obvious which of the compositions of Yamashiki et al. would work in the present invention, or with what adhesion promoters.

It is also noted and considered by the PTO that the numerous insoluble additives added to the composition to make it a paste, because of their solvent insolubility, provide a substantial amount of solvent resistance to the film when the photoresist is coated on top for the patterning step in Yamashiki et al. Thus, certain compositions of Yamashiki et al. would work in that application but not in the application of the present invention because they lack the required solvent resistance without the additives. Some Yamashiki et al's compositions do not meet criteria #3 (see page 3 of this Response) of the present invention.

These additional considerations further establish the unobviousness of the claims of this application over the disclosure in Yamashiki et al. taken with Matsuoka et al. and the erroneousness of the rejection of claims 1-12,14,17-29, 31 and 34-36 over these two citations, and the withdrawal of this rejection is respectfully requested.

The deficiencies in the prior discussed rejection also are applicable to the two other obviousness prior art rejections of claims of claims 15, 16, 32 and 33 (over the primary references with either Madhi et al or Nakamura et al.) since these two further rejections of those other claims are also predicated upon the disclosures in Yamashiki et al. and Matsuoka et al. as primary reference and upon the USPTO's erroneous use thereof for the reasons already stated. Thus, these prior art obviousness rejections of claims 15, 16, 32 and 33 are erroneous and their withdrawal is also respectfully requested.

Claims 15, 16, 32 and 32 are also erroneously rejected for obviousness under 35 U.S.C. 103 by the USPTO over Yamashiki et al in view of Matsuoka et al, further in view of Mahdi et al. (US 2002/0100550 A1) for the following additional reasons.

Mahdi et al is cited by the USPTO to show the equivalence of 3-methacryloxypropyltrimethoxysilane with phenylaminopropyltrimethoxysilane. The only basis for this is the mere fact that they are both mentioned in a list in the Mahdi et al. application disclosure. However, the mere fact that they are mentioned in the same listing in this application provides no basis for any factual basis that they are equivalent for the purposes of the present invention. Moreover, the fact that they both work under the conditions in the cited application is not a basis for contenting that they are equivalent in a different environment, i.e., in the compositions of the present invention. Since, as noted in detail before, adhesion is a function of all of the chemistry in the composition and on the substrate as well as physical interactions of key components. Thus, the PTO's assertion of equivalency is totally unfounded. Even if the two adhesion promoters are equivalent in the particular environment of that Mahdi et al. patent application, any conclusions therefrom must, according to the knowledge on one skilled ion this art, be restricted to the very specific environment in which the equivalence conclusion is made. The ability for promoting adhesion depends on the chemistry of the specific compounds in the composition and the surface to which the adhesion is being promoted. In Mahdi et al, the environment is in an epoxy matrix along with numerous other materials to hold window

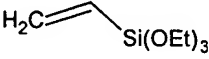
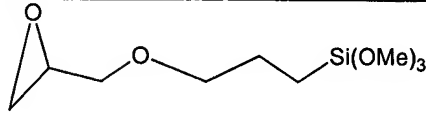
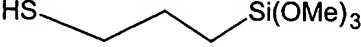
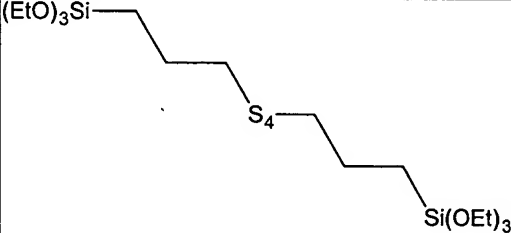
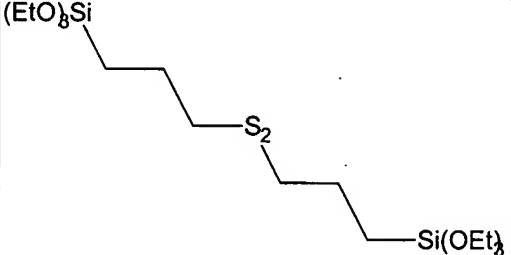
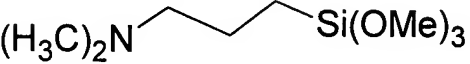
panes in the frame. There is no disclosure or teaching in Mahdi et al. to add any of their adhesion promoters to polyamic precursor compositions, let alone to polyamic acid precursor compositions. Asserting that because Mahdi et al. teaches the equivalence of the two adhesion promoters in its environment of epoxy polymers and window panes, they would work equivalently in Matsuoka et al. on a semiconductor substrate with polyamic acid **diesters**, and then further asserting that they would work in the polyamic acid formulations on a semiconductor substrate is a totally unsupported and unwarranted assertion that is legally indensible in view of the aforementioned knowledge of those skilled in the art of the present invention.. This is totally non-relevant art bearing no relation to semiconductor substrates and polyamic acid compositions and thus has no standing or consideration to establishing equivalency or obviousness for use in the compositions and process of the present application.

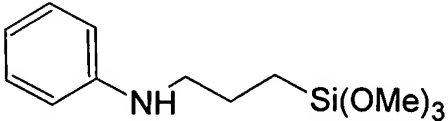
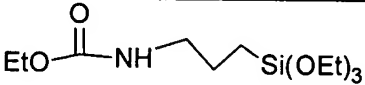
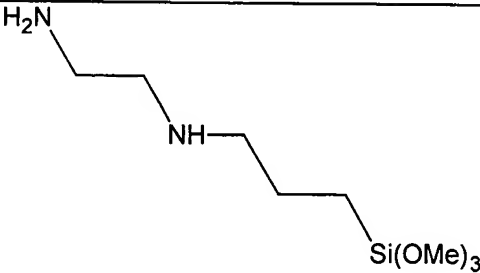
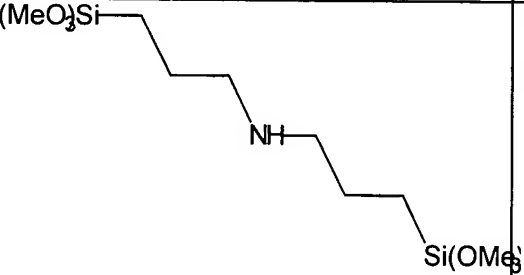
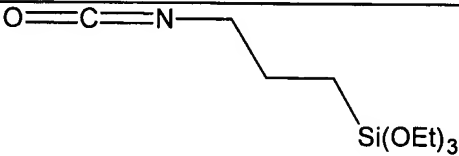
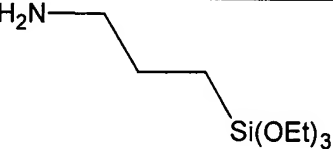
Claims 16 and 33 are also erroneously rejected for obviousness under 35 U.S.C. 103 by the USPTO over Yamashiki et al in view of Matsuoka et al, further in view of Nakamura et al. (US 5,908,897) for the following additional reasons. The PTO relies upon Nakamura et al. for further supporting the contention that it would be obvious to add an adhesion promoter to polyimide precursor compositions in order to improve adhesion property of the polyimide coating film to a substrate. The same reasoning as stated above with respect to the Madhi et al application reference is applicable here. Nakamura et al. relates to a totally non-relevant prior art relating to a different environment (a rubber composition with different chemistries, components, surface energies etc). The mere fact that adhesion promoters are mentioned in the same listing in this Nakamura et al. patent provides no basis for a ny factual basis that they are equivalent for the purposes of the present invention. Moreover, the fact that they both work under the conditions in the cited patent is not a basis for contenting that they are equivalent in a different environment, i.e., in the compositions of the present invention. Since, as noted in detail before, adhesion is a function of all of the chemistry in the composition and on the substrate as well as physical interactions of key components. Thus, the PTO's assertion of equivalency is totally unfounded. Even if the two adhesion promoters are equivalent in the particular environment of that Nakamura et al patent, any conclusions therefrom must, according to

the knowledge on one skilled ion this art, be restricted to the very specific environment in which the equivalence conclusion is made. The ability for promoting adhesion depends on the chemistry of the specific compounds in the composition and the surface to which the adhesion is being promoted. In Nakamura et al. the environment is in an rubber matrix along with numerous other materials to hold window panes in the frame. There is no disclosure or teaching in Nakamura et al.. to add any of their adhesion promoters to polyamic precursor compositions, let alone to polyamic acid precursor compositions. Asserting that because Nakamura et al. teaches the equivalence of the two adhesion promoters in its environment of rubber compositions in a different environmemt, they would work equivalently in Matsuoka et al. on a semiconductor substrate with polyamic acid **diesters**, and then further asserting that they would work in the polyamic **acid** formulations on a semiconductor substrate is a totally unsupported and unwarranted assertion that is legally indensible in view of the aforementioned knowledge of those skilled in the art of the present invention. This is totally non-relevant art bearing no relation to semiconductor substrates and polyamic acid compositions and thus has no standing or consideration to establishing equivalency or obviousness for use in the compositions and process of the present application.

In fact, the data in the present application shows that that USPTO conclusion of equivalence in respect to all three rejections is erroneous when attempted to be applied to the compositions of the present invention. By the logic of the USPTO any of the adhesion promoters of Mahdi et al. or Nakamura et al. would be expected to perform equivalently in any environment and particularly in the environment of Applicants' claims. However, as the data in Applicants' comparative examples 9 and 11 (paragraphs [0069] and [0070]) shows this is not the case. This data shows that one can not merely pull any adhesion promoter out of the hat (including all those in table 6 of Mahdi et al. or those of Nakamura et al.) and expect that they will perform in the compositions of this invention to produce the stable compositions required. Comparative examples 9 and 11 show that such is not the case and that there is no basis for obviousness as erroneously contended by the USPTO. The PTO erroneously dismisses the showing in Table 3 as unpersuasive based on the assertion that the distinctions are not clear. It is respectfully submitted that the

distinctions are quite clear between gelled and stable and adhesion performance. If the composition gelled it was not suitable and Table 3 clearly establishes that patentable distinction. For the convenience of the PTO and the Examiner the stability time periods are set forth in the following more explicit listing of the results in Table 3.

| Example # | Adhesion promoter structure | Formulation stability after 24 hours | Formulation stability after 3 weeks* |
|-----------|---|--------------------------------------|--------------------------------------|
| 11 |  | stable | Stable |
| 12 |  | stable | Stable |
| 13 |  | stable | Stable |
| 14 |  | stable | Stable |
| 15 |  | stable | Stable |
| 16 |  | stable | Stable |

| | | | |
|------------------------|---|-----------------------|---|
| 17 |  | stable | Stable |
| 18 |  | stable | stable, (was not gelled after 18 weeks) |
| Comparative example 8 |  | Gelled immediately | |
| Comparative Example 9 |  | Gelled immediately | |
| Comparative Example 10 |  | stable | Gelled |
| Comparative Example 11 |  | Gelled within an hour | |

*Unless otherwise noted, observations were terminated after 3 weeks

It should be noted, that when the formulations gelled, it is not possible to compare the adhesion of different promoters to show superiority. The above table shows that all of the examples of the invention did not gel after three weeks. The test for one of the samples was continued for a total of 18 weeks and it did not gel. The formulations were made late in the day and not observed until the next morning so gelling took place in < 24 hours. The samples were observed again three weeks later, [not observed between 24 hours and 3 weeks]. Comparative example 10 gelled sometime within the three-week period, but the exact time is unknown since the samples were not observed in between 24 hours and three weeks. (To determine more precisely the exact gelling time of Comparative Examples 8, 9, and 11 the inventors had them rerun. Comparative Examples 8 and 9 gelled immediately and 11 gelled within an hour.) The results in this table show clearly that there is a substantial difference in stability of the formulations with different adhesion promoters and that it is not obvious which ones will be stable.

Additionally, the Office Action erroneously criticizes the comparative data as insufficient because there is not a comparison with "the closest prior art". This criticism is erroneous since the the Action erroneously states that the closest prior art is "Yamashiki's polyamic acid composition **combined** with Matsuoka's adhesion promoters". Such a composition is made up by the PTO and is found in no prior art reference. The PTO cannot make up a theoretical composition from the prior art and call it the "closest prior art".

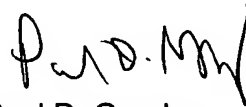
For these additionally reasons the USPTO is respectfully requested to reconsider and withdraw these prior art rejections of claims 15, 16, 32 and 33 as well as the previously discussed rejection of claims 1-12, 14, 17-39, 31 and 34-36.

The provisional rejection of claims 1-7, 14-24 and 31-36 under the judicially created doctrine of obviousness-type double patenting over claim 1 and 3-13 of application no. 10/732,097 is obviated by the attached Terminal Disclaimer and requisite fee therefore. In view of this the PTO is respectfully requested to withdraw this double patenting rejection.

It is respectfully submitted that the foregoing is a full and complete response to the Office Action and that all the claims are allowable for at least the reasons indicated. An early indication of their allowability by issuance of a Notice of Allowance is earnestly solicited.

Respectfully submitted,

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